Patent
Attorney Docket No. GEMS8081.152

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Foo et al.
Serial No.	:	09/682,685
Filed	:	October 5, 2001
For	:	Efficient Multi-Slice Acquisition With Black Blood Contrast In Fast Spin Echo Imaging
Group Art No.	:	3737
Examiner	:	Smith, R.

CERTIFICATION UNDER 37 CFR 1.8(a) and 1.10

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APPEAL BRIEF PURSUANT TO 37 C.F.R. §§1.191 AND 1.192

Dear Sir:

This Appeal Brief is being filed in furtherance to the Notice of Appeal faxed to the Board of Patent Appeals on September 2, 2004.

1. REAL PARTY IN INTEREST

The real parties in interest are General Electric Company and GE Medical Systems Global Technology Company, LLC, an Assignee of the above-referenced

application by virtue of the Assignment to GE Medical Systems Global Technology Company, LLC, recorded on August 7, 2003, at reel 13855, frame 0812, and Mount Sinai Medical Center by virtue of the Assignment to Mount Sinai Medical Center recorded on August 7, 2003, at reel 013855, and frame 0816.

2. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellant's legal representative in this Appeal. GE Medical Systems Global Technology Company, LLC, and Mount Sinai Medical Center, the Assignees of the above-referenced application, as evidenced by the documents mentioned above, will be directly affected by the Board's decision in the pending appeal.

3. STATUS OF THE CLAIMS

Claims 1-29 are currently pending, claims 1-20 have been allowed, and claims 21-29 are currently under final rejection and, thus, are the subject of this appeal.

4. STATUS OF AMENDMENTS

No Amendments have been made since the final Office Action mailed May 3, 2004.

5. SUMMARY OF THE INVENTION AND OF THE DISCLOSED EMBODIMENTS

The present invention relates to an MR pulse sequence, apparatus, and a technique for efficient multi-slice acquisition with black blood contrast in fast spin echo imaging. See Application, pg. 3.

The proposed technique includes a non-selective inversion RF pulse, followed by a broad-band slice selective pulse that re-inverts the spins in the slab encompassing the slices to be imaged. After an inversion time, RF excitation pulses with a fast spin echo readout are executed acquiring data for each spatial slice in an order that provides optimal blood suppression. The inversion time is preferably selected such that the blood signal is close to the null point. This technique differs from conventional gated fast spin echo

imaging with black blood image contrast in that the re-inversion or tip-up pulse in the conventional technique is effective only in a single slice of interest which results in only one slice or spatial section acquired per breath-hold or acquisition. The present invention allows for multi-slice acquisition. See Application, pg. 3.

A method of multi-slice fast spin echo image acquisition with black blood contrast is disclosed that includes a non-selective inversion pulse and applying a re-inversion pulse that is slice selective over a region encompassing a plurality of slice selections. The method includes timing execution of the series of RF excitation pulses with fast spin echo readout such that signal from black blood is near a null point. Data is then acquired for each spatial slice. See Application, pg. 3.

A computer program is disclosed for multi-slice coverage in a single acquisition with black blood T_2 –weighted image contrast. The computer program has a set of instructions that when executed by a computer cause a computer to generate and cause application of a non-selective inversion RF pulse to a slab of slices, each having a predefined thickness. The computer program also causes the computer to generate and cause application of a slice selective re-inversion RF pulse having a slice thickness greater than the predefined thickness of a single slice and apply an inversion time so that a null point of blood within the slab occurs in a middle of an acquisition. A series of RF excitation pulses is applied and MR data is acquired for each slice in the slab. See Application, pgs. 3-4.

An MR apparatus to produce consistent contrast in FSE image acquisition is disclosed. The apparatus includes an MRI system having a number of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF modulator controlled by a pulse control module to transmit RF signals to an RF coil assembly to acquire MR images. The MRI apparatus also includes a computer programmed to apply a pulse sequence having a non-selective inversion pulse to invert spins in a longitudinal direction across an entire slab of slices and a slice selective re-inversion pulse having an implied width at least as large as that of the non-selective inversion pulse. The pulse sequence applied by the computer also has a series of excitation pulses having fast spin echo readout spaced apart from the slice

selective re-inversion pulse by an inversion time to acquire data for each slice in the slab. See Application, pg. 4.

A pulse sequence for use in multi-slice MR data acquisition is disclosed. The pulse sequence includes a non-selective inversion pulse applicable to a slab of slices and a slice selective re-inversion pulse applicable to at least a number of the slices in the slab of slices. The pulse sequence also includes a series of fast spin echo readout excitation pulses applicable to the at least a number of slices in the slab of slices after an inversion time. Preferably, the aforementioned inversion time is selected so that blood in the slab is at or near the null point. See Application, pgs. 4-5.

6. GROUNDS OF REJECTION

Claims 21-29 stand rejected under 35 U.S.C. §101 as being directed to non-statutory subject matter.

7. REJECTION UNDER 35 U.S.C. §101

As discussed in detail below, the Examiner has improperly rejected claims 21-29. The Examiner finally rejected claims 21-29 and stated that "[a] pulse sequence is considered to be a type of signal which does not encompass any of the statutory categories of invention." Office Action, pg. 2 (May 3, 2004). The Examiner further asserted that "[t]he claims are not directed to a practical application" and that "[t]he claims fail to positively set forth any means for producing the pulses or means for acquiring MR data after the pulses have been applied to a patient's body." Id. The Examiner then concluded that "the claims merely set forth a series of pulses of electromagnetic radiation with intended use that they be directed to a slab of slices in the patient's body." Id.

Contrary to the Examiner's conclusions, Appellant respectfully disagrees that claims 21-29 are directed to non-statutory subject matter. It is generally recognized that "anything under the sun that is made by man" may be patentable with three notable exceptions: abstract ideas, laws of nature, and natural phenomena. See MPEP §2106.IV.A. "These three exclusions recognize that subject matter that is not a practical application or use of an idea, a law of nature or a natural phenomenon is not patentable."

Id. In short, a claim directed to the practical use of natural phenomenon is patentable, but the natural phenomenon itself is not.

The Examiner has asserted that the subject matter of claims 21-29 is directed to a non-practical application of magnetism. See Office Action, supra, at 2. The Examiner's assertions illustrates that the Examiner has failed to appreciate that which is claimed. As recognized in the art and admitted by the Examiner, a "pulse sequence" is characterized as "a series of RF pulses and/or magnetic field gradients applied to a spin system to produce a signal representative of some property of the spin system." See The Basics of MRI, http://www.cis.rit.edu/htbooks/mri/inside.htm (copy attached as Addendum A). Claim 21 calls for a "pulse sequence" comprising a non-selective inversion pulse, a slice-selective re-inversion pulse, and a series of excitation pulses that are played out for multi-slice MR data acquisition. While the principles of RF energy and magnetism are employed to achieve the multi-slice MR data acquisition, Appellant has not claimed principles, but has claimed a pulse sequence, as defined by the claim limitations, which is directed to more than just RF energy and magnetism. The pulse sequence is signals defined by an ordered application of RF and magnetic energy to achieve the practical end of multi-slice MR data acquisition. Moreover, there is no evidence that this ordered application occurs naturally. Moreover, one skilled in the art of MR imaging would acknowledge that it is the practical application of RF and magnetic energy that makes MR imaging viable.

Appellant believes an example will further illustrate this point. Fallen sticks of wood from a tree are a naturally occurring product of nature. It is well recognized, however, that arranging sticks of wood into a chair is a practical application of the wood that makes the chair patentable subject matter. The same analysis can be applied to that called for in claims 21-29. RF energy and magnetism are naturally phenomena; however, it is their application in a non-naturally occurring order to acquire MR data that illustrates one example of their practicality.

Additionally, the Examiner acknowledged that "[a] pulse sequence is considered to be a type of signal..." Office Action, supra, at 2. MPEP §2106.IV.B.1(c) states that:

> **[A] signal claim directed to a practical application of electromagnetic energy is statutory regardless of its transitory nature. See O'Reilly, 56**

U.S. at 114-19; In re Breslow, 616 F.2d 516, 519-21, 205 USPQ 221, 225-26 (CCPA 1980). MPEP §2106.IV.B.1(c).

The Examiner also has admitted the practical application of the signal in stating that "the claims merely set forth a series of pulse of electromagnetic radiation with intended use that they be directed to a slab of slices in the patient's body". Office Action, supra at pg. 2.

As set forth above, the subject matter of claims 21-29 is directed to the application of electromagnetic energy to multi-slice acquisition of MR data. Therefore, given the Examiner's own admission that the "pulse sequence is considered to be a type of signal" and the application of that "signal" to the practical and useful end of MR data acquisition, the Examiner's rejection under 35 U.S.C. §101 cannot be sustained and, thus, should be withdrawn.

8. CONCLUSION

Although magnetism and RF emissions are naturally occurring phenomena and are thus not patentable in the abstract, in MR imaging, these phenomena are manipulated and exploited to acquire MR data. It is the generation and manipulation of magnetic fields and RF signals through a pulse sequence that characterizes the use of these phenomena to a new and useful end. In this regard, a "pulse sequence" defines the manner in which these naturally occurring phenomena are to be exploited to reach a new and useful end, namely, "multi-slice MR data acquisition."

Since claims 21-29 are directed to a sequence of specific and uniquely tailored pulses that have practicality in MR data acquisition, Appellant respectfully submits that the Examiner has provided no supportable position or evidence that claims 21-29 are directed to non-statutory subject matter.

Incidentally, USP 6,498,946, from which the present application claims priority, also has "pulse sequence" claims. Appellant respectfully requests that the Board direct withdrawal of all outstanding rejections and direct the present application be passed to issuance.

General Authorization for Extension of Time

In accordance with 37 C.F.R. §1.136, Appellant hereby provides a general authorization to treat this and any future reply requiring an extension of time as incorporating a request therefore. Prior authorization has been given authorizing charging Deposit Account No. 07-0845 fees associated with the above-captioned matter. Accordingly, Appellant requests that the $340.00 fee for filing this Appeal Brief Under 37 C.F.R. §1.17(c) be charged against Deposit Account No. 07-0845.

Respectfully submitted,

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APPENDIX OF CLAIMS ON APPEAL

1. (Allowed) A method of multi-slice image acquisition with black-blood contrast comprising:

applying a non-selective inversion pulse;

applying a re-inversion pulse that is slice-selective over a region encompassing a plurality of slice selections;

timing execution of a series of RF excitation pulses such that signal from blood is near a null point; and

acquiring data for the plurality of slice selections.

2. (Allowed) The method of claim 1 wherein the plurality of slice selections include all slice selections in a slab to be imaged.

3. (Allowed) The method of claim 1 wherein the images are acquired over more than a single breath-hold.

4. (Allowed) The method of claim 1 wherein the re-inversion pulse is applied over a region having all slice selections in a slab and data are acquired for all slice selections in the slab using a single re-inversion pulse.

5. (Allowed) The method of claim 1 further comprising creating the inversion pulse with slice thickness given by:

slice thickness = $(Z_1 - Z_n) + 4 *$ opslthick,

where Z_1 and Z_n represents spatial locations of first and last slices selected for imaging, and opslthick represents a desired imaging slice thickness.

6. (Allowed) The method of claim 5 further comprising creating the re-inversion pulse with a center centered about a midpoint between Z_1 and Z_n.

7. (Allowed) The method of claim 1 wherein the timing step includes selecting an inversion time TI such that the null point of the blood occurs near a center of the multi-slice acquisition.

8. (Allowed) The method of claim 1 further comprising modifying a flip angle of RF excitation pulses executed before and after an occurrence of the null point of the blood to improve blood suppression.

9. (Allowed) The method of claim 8 further comprising modifying the flip of RF excitation pulses occurring before the null point to slightly less than 90° and those occurring after the null point to slightly more than 90°.

10. (Allowed) A computer program stored on a computer readable storage medium and having a set of instructions that when executed by a computer cause the computer to:

(A) generate and cause application of a non-selective inversion RF pulse to a slab of slices each having a thickness;

(B) generate and cause application of a slice-selective re-inversion RF pulse having a slice thickness greater than the thickness of a single slice;

(C) apply an inversion time;

(D) apply RF excitations; and

(E) acquire MR data.

11. (Allowed) The computer program of claim 10 wherein the slice thickness of the re-inversion pulse is selected greater than the slab of slices to allow for cardiac motion between the application of the slice-selective re-inversion RF pulse, and the acquisition of MR data.

12. (Allowed) The computer program of claim 10 wherein the RF excitations have a flip angle greater than 90° for segments after a null point and less than 90° for segments before the null point.

13. (Allowed) The computer program of claim 10 wherein acts (A) – (E) are carried out over one or more R-R intervals.

14. (Allowed) The computer program of claim 10 wherein the MR data is acquired during mid-diastole of an R-R interval.

15. (Allowed) An MR apparatus to produce consistent contrast in image acquisition comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to apply a pulse sequence having:

a non-selective inversion pulse to invert spins in a longitudinal direction across an entire slab of slices;

a slice-selective re-inversion pulse having an implied width at least as large as that of the non-selective inversion pulse; and

a series of excitation pulses spaced apart from the slice-selective re-inversion pulse by an inversion time.

16. (Allowed) The MR apparatus of claim 15 wherein the slice-selective re-inversion pulse of the pulse sequence is further defined as having a width greater than that of the non-selective inversion pulse to extend on either side of the non-selective inversion pulse.

17. (Allowed) The MR apparatus of claim 16 wherein the slice-selective re-inversion pulse extends approximately twice the nominal slice thickness on either side of the non-selective inversion pulse.

18. (Allowed) The MR apparatus of claim 15 wherein the inversion time of the pulse sequence is selected such that blood signal is close to a null point.

19. (Allowed) The MR apparatus of claim 18 wherein the series of excitation pulses have therein excitation pulses with differing flip angles.

20. (Allowed) The MR apparatus of claim 19 wherein excitation pulses occurring near a mid-point of the series have a flip angle near 90° and excitation pulses occurring before a mid-point have a flip angle less than 90° and excitation pulses occurring after the mid-point have a flip angle more than 90°.

21. (On Appeal) A pulse sequence for use in multi-slice MR data acquisition comprising:

a non-selective inversion pulse applicable to a slab of slices;

a slice-selective re-inversion pulse applicable to at least a number of slices in the slab of slices; and

a series of excitation pulses applicable to the at least a number of slices in the slab of slices after an inversion time.

22. (On Appeal) The pulse sequence of claim 21 wherein the inversion time is selected to allow signal from blood in a mid-point of the at least a number of slices to approach a null point.

23. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes all slices in the slab of slices.

24. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes fewer slices than those in the slab of slices but more than one.

25. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes more slices than those in the slab of slices.

26. (On Appeal) The pulse sequence of claim 21 wherein the non-selective inversion pulse has a thickness given by:

slice thickness = $(Z_1 - Z_n) + 4$ * opslthick,

where Z_1 and Z_n represents spatial locations of first and last slices selected for imaging, and opslthick represents a desired imaging slice thickness.

27. (On Appeal) The pulse sequence of claim 26 wherein the slice-selective re-inversion pulse has a center centered about a mid-point between Z_1 and Z_n.

28. (On Appeal) The pulse sequence of claim 21 wherein the series of excitation pulses have varying flip angles.

29. (On Appeal) The pulse sequence of claim 28 wherein excitation pulses that occur before a mid-point of the series have a flip angle of less than 90°, those near the mid-point have a flip angle near or at 90°, and those that occur after the mid-point have a flip angle greater than 90°.